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INSULATOR

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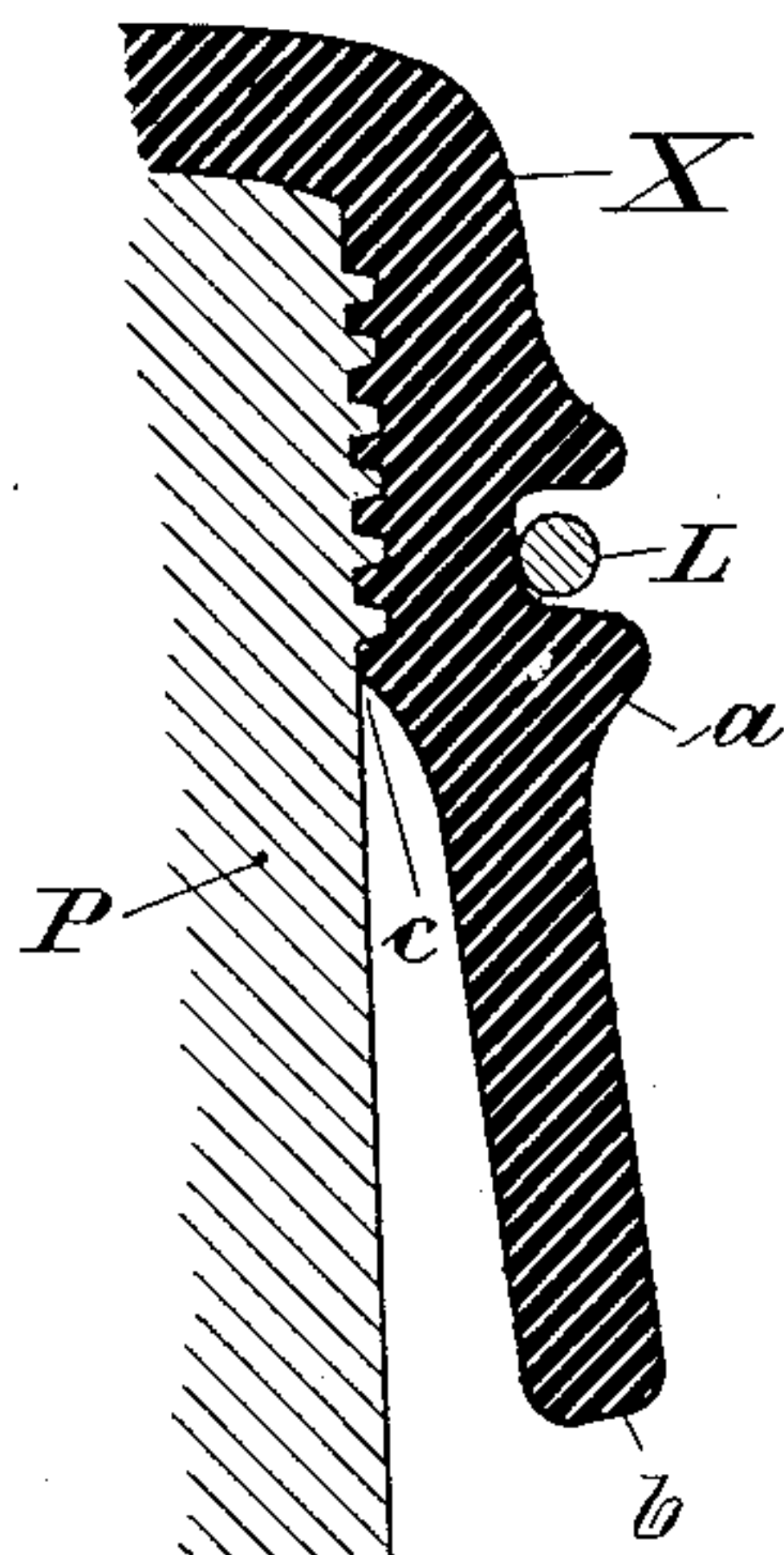


Fig. 1

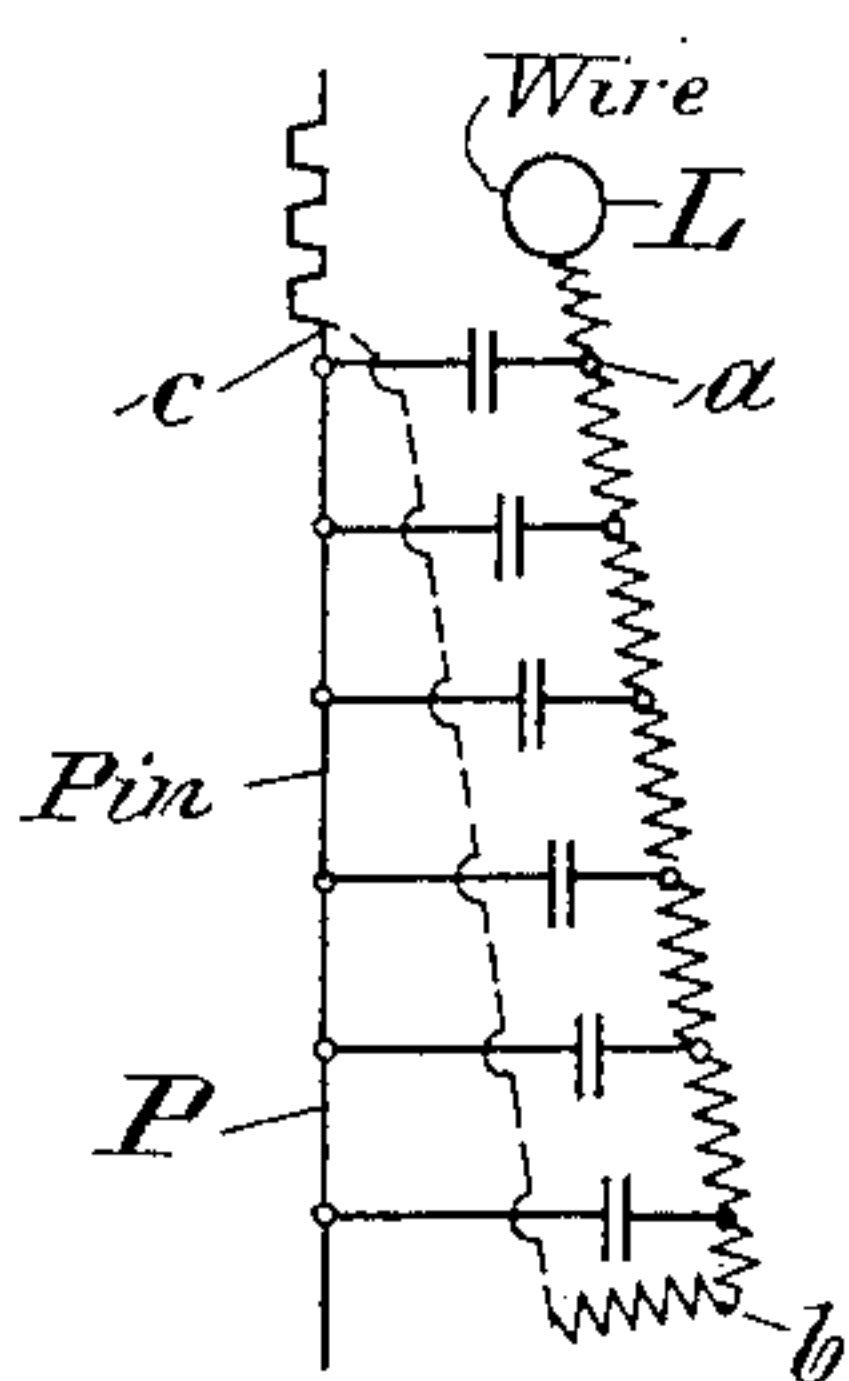


Fig. 2

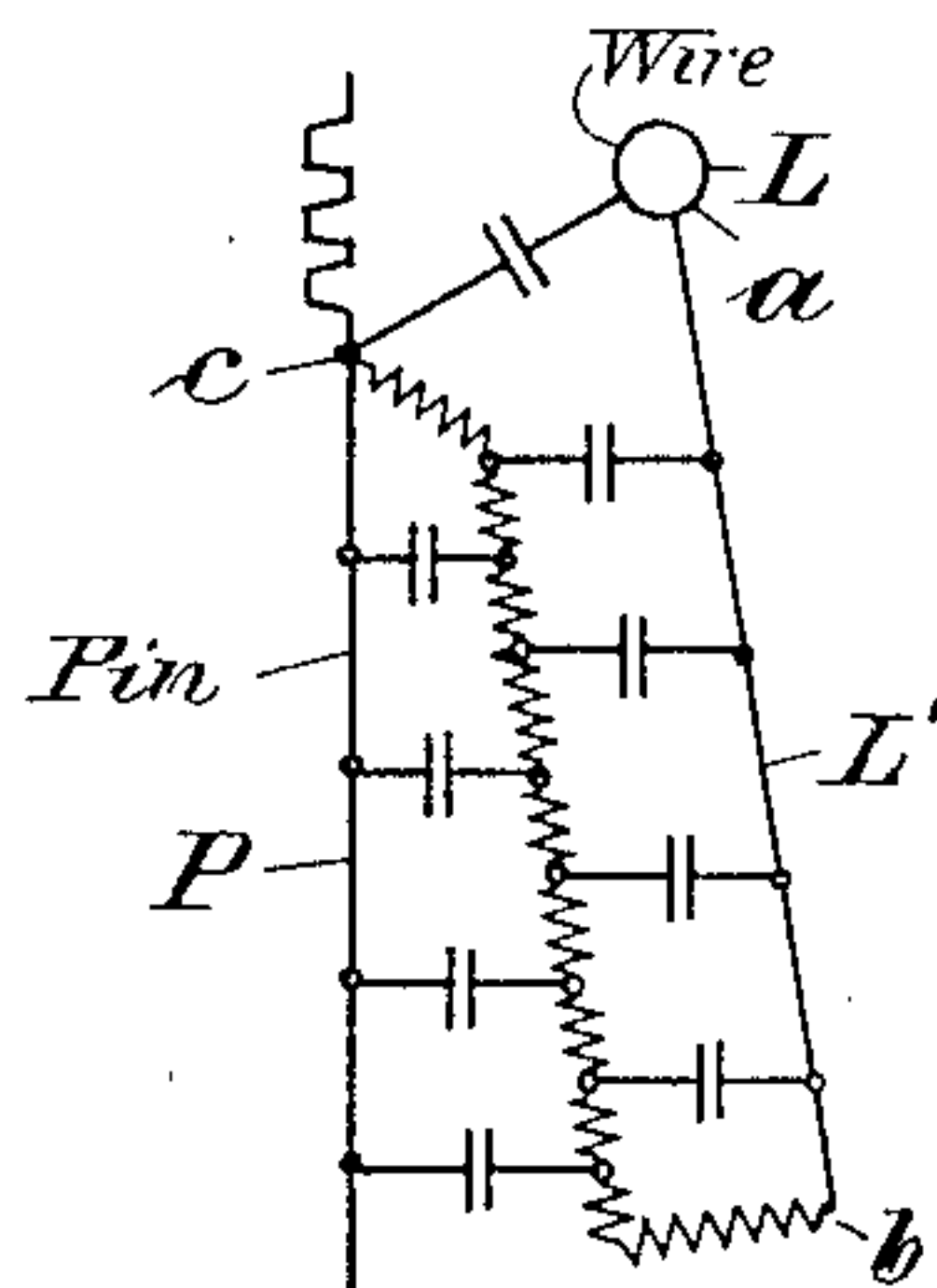


Fig. 3

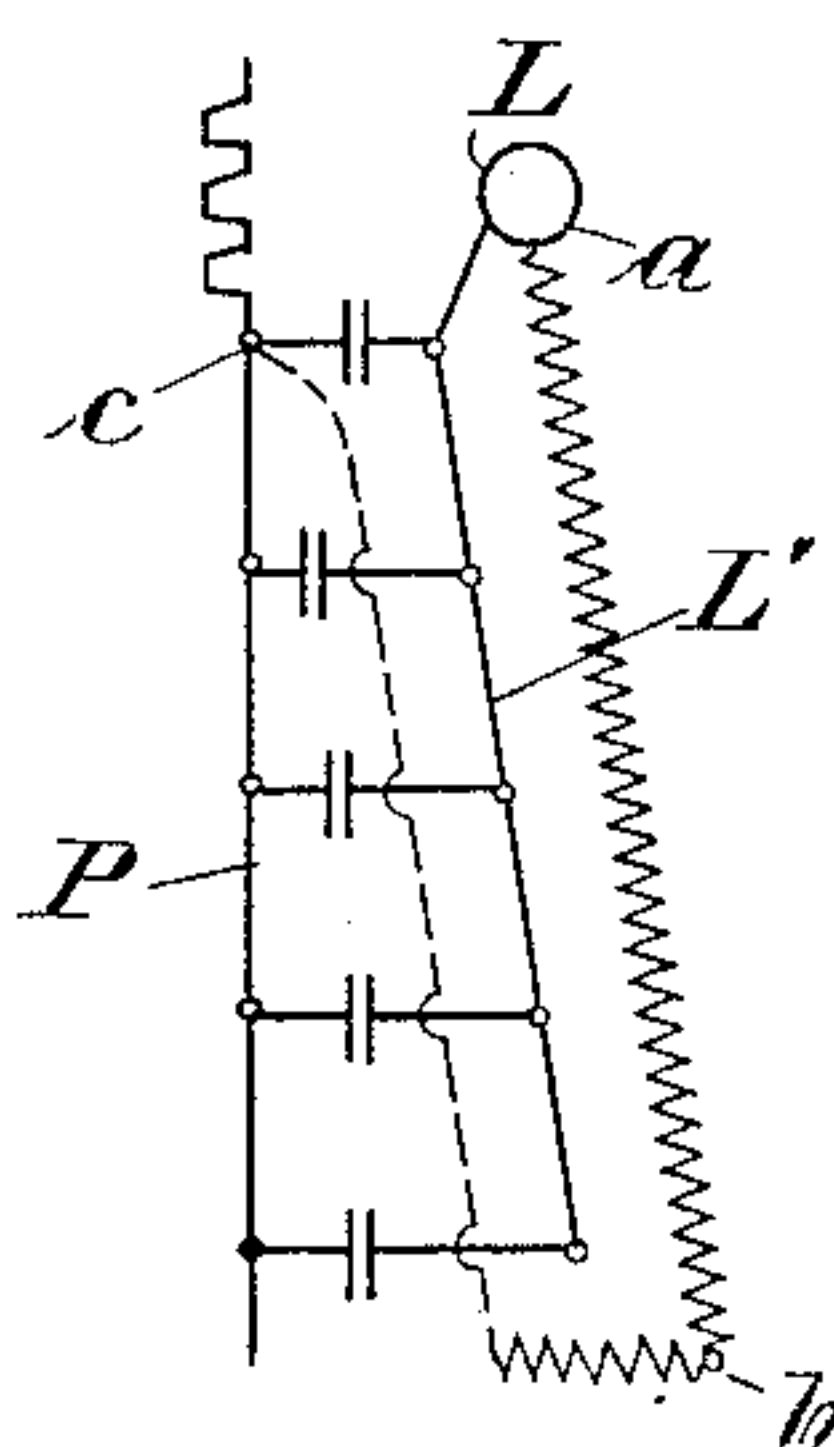


Fig. 4

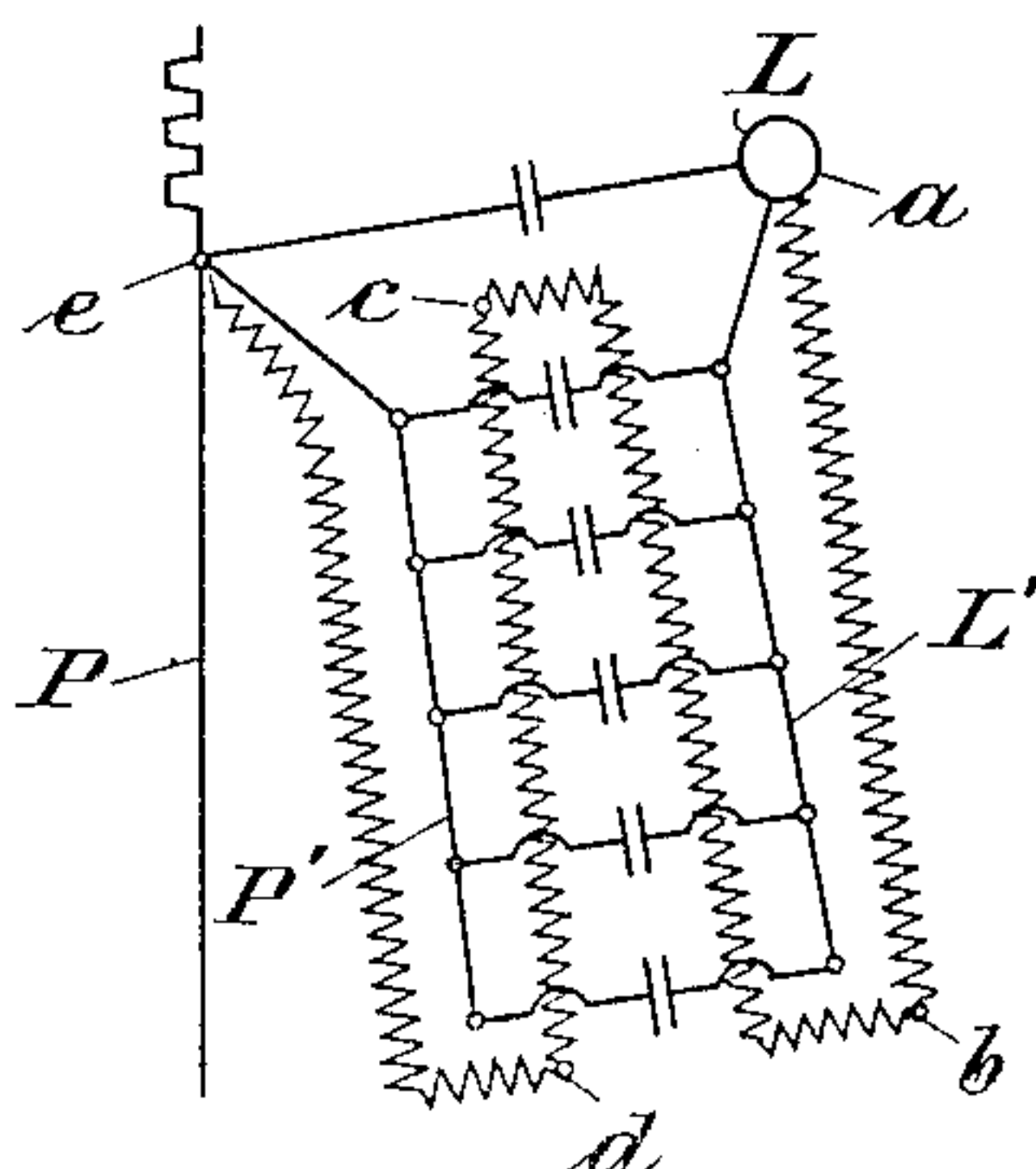


Fig. 5

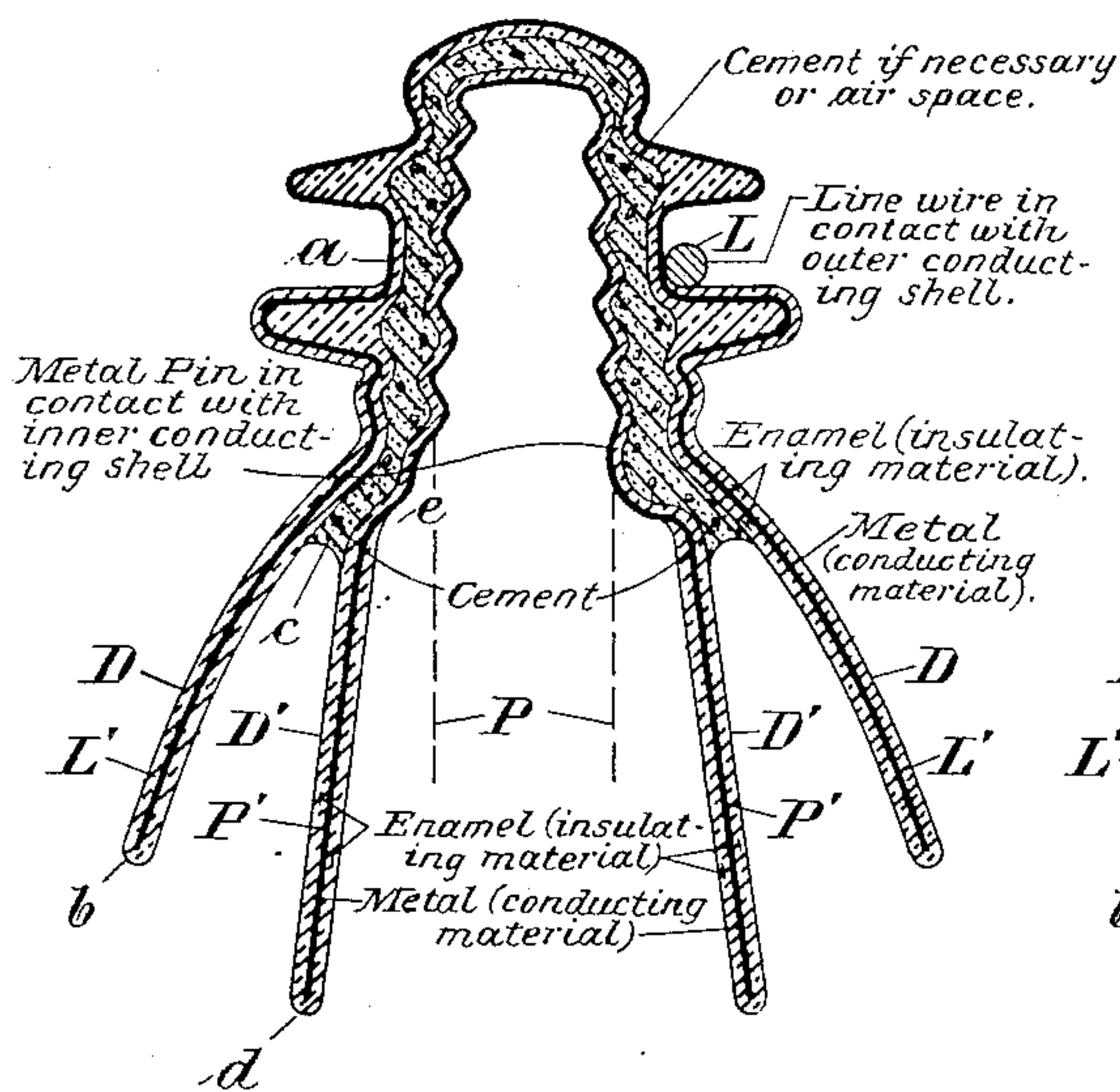


Fig. 6

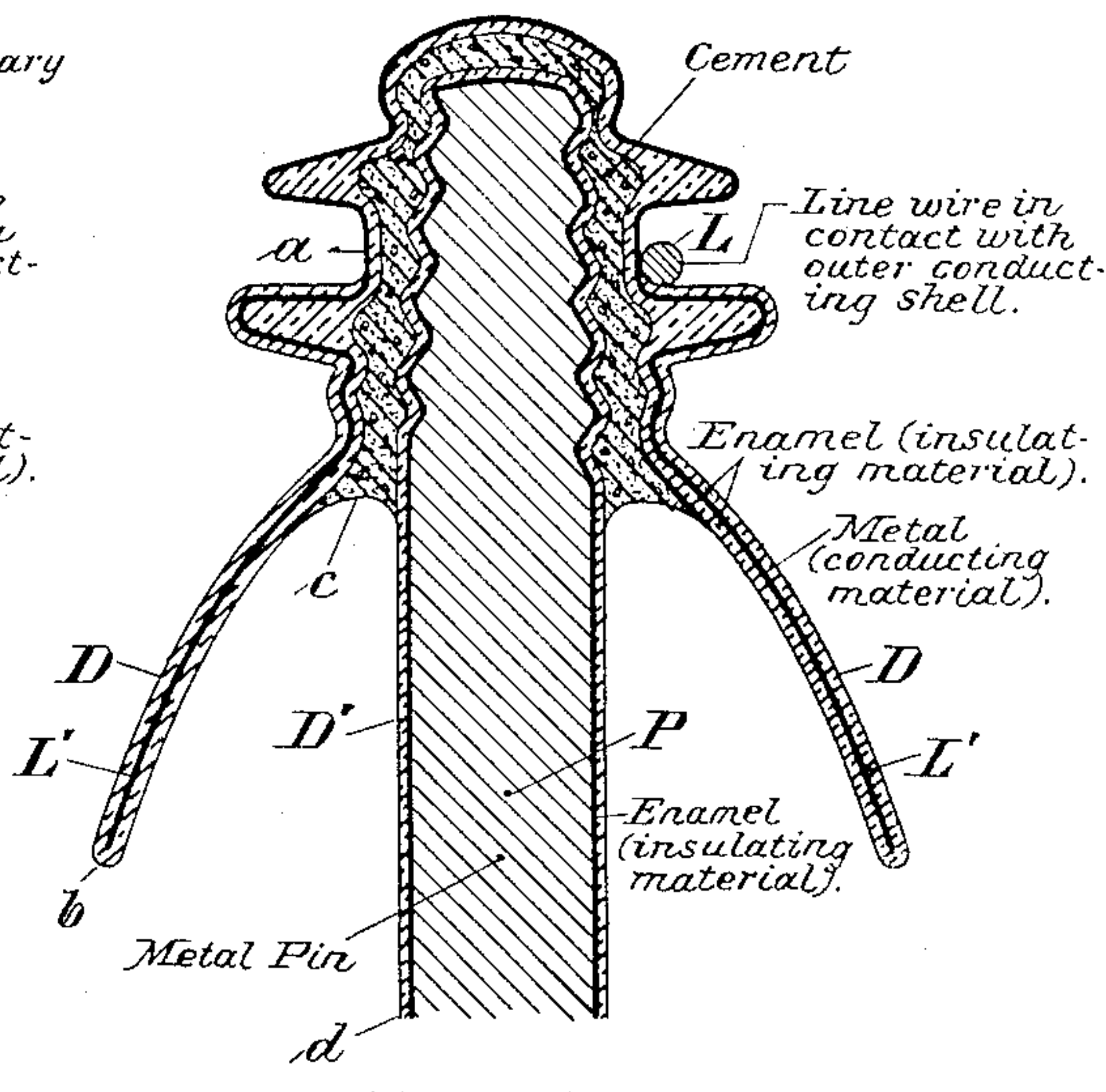


Fig. 7

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1,927,106

INSULATOR

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12 Claims. (Cl. 173—28)

This invention relates to insulators, and more particularly to insulators which are capable of use in connection with carrier transmission circuits.

5 Experience shows that one of the principal causes of leakage in connection with insulators at carrier frequencies is due to alternating current surface losses. The insulator may be considered from this standpoint as having a high
10 resistance distributed along the outer surface of the insulator and the inner surface of the skirt between the line wire and the pin, with distributed capacity among the various elements of this surface and between them and the pin. It will
15 be evident that if this entire surface resistance could either be made infinite or zero, the transfer of energy through the capacity of the insulator alone would be a wattless transfer of energy so that the effect of the insulator would be merely
20 to change the phase of the current transmitted over the line without introducing any loss.

To reduce the surface resistance to substantially zero might be accomplished by applying a metal coating to both the outer surface of the
25 insulator and the inner surface of the skirt, but this would short-circuit the protected dry path afforded by the skirt and the leakage would be greater than without any coating at all. In view of this difficulty it has been proposed to coat the
30 outside surface of the insulator only. Coating the outside of the insulator increases the direct current component of leakage by an amount depending upon the insulator shape, the state of aging, and nature of the weather conditions.
35 Where only mild changes in the weather occur, the direct current component is small. However, in the case of a heavy splashing rain or where wet snow is piled up around the insulator so that the protected path is completely shunted by the
40 snow, the increase in the direct current component may be quite serious. Coating the outside of the insulator also tends to increase alternating current surface losses occurring on the inside surface of the skirt. Under ordinary
45 weather conditions this inside surface has such a high resistance that the surface loss effect is small. Where a heavy rain occurs, however, the wetting of the inner surface reduces its resistance. This reduced resistance, taken in connection with the relatively large capacity between
50 the inner wet surface and the outer metal coating, sometimes results in a higher leakage in the upper carrier range with a metal-coated insulator than would occur under the same conditions with an uncoated insulator.
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In accordance with the present invention, it is proposed to overcome these difficulties by reversing the structural organization, that is, by providing a skirt of conducting material which is coated with dielectric material instead of having
60 a skirt of dielectric material coated with a conductor. If the metallic part of the skirt which is embedded in the dielectric is connected to the line wire, the capacity from the line wire to the pin is practically all distributed along the surface
65 of the conducting element of the skirt. The embedded conducting element in effect by-passes both the outer and inner surfaces of the skirt of the insulator so that the transfer of energy from the wire to the pin is substantially a wattless
70 transfer of energy without any leakage loss along the surface of the dielectric. As a further refinement the insulator may be provided with two metallic elements, one in direct metallic contact with the pin and the other in direct metallic con-
75 tact with the line wire, both elements being embedded in dielectric material and being separated from each other by dielectric so that the outer one constitutes a skirt and the inner one a
80 petticoat. This results in a structure which has a very long protected dry path and a structure in which the capacity between the line wire and the pin is distributed between the surfaces of the two metallic elements embedded in the skirt and
85 petticoat, respectively. The wattless energy transfer path thus afforded acts as a substantially complete shunt to any path which includes the surface of the insulator.

The invention will now be more fully understood by reference to the following description,
90 when read in connection with the accompanying drawing, in which Figure 1 is a section showing a part of a normal insulator construction; Fig. 2 is a diagram showing the electrical equivalent of the ordinary insulator arrangement; Fig. 3 is a
95 similar diagram for the insulator with its outer surface coated; Fig. 4 is a diagram showing the equivalent electrical circuit of an insulator in accordance with the invention, having a single metallic skirt embedded in dielectric material;
100 Fig. 5 is a similar diagram for the case where two metallic elements embedded in dielectric material are provided; and Figs. 6 and 7 show insulators so constructed as to embody the principles illustrated in Fig. 5.
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Let us consider the case of an ordinary telephone insulator such as shown in Fig. 1 where X designates the body of the insulator which may be screwed upon a metallic or wooden pin P, the line wire L being embedded in a suitable groove
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in the insulator X. That part of the insulator shown in section at $a-b-c$ is the skirt of the insulator which affords a protected dry path between b and c .

5 Such an insulator construction is electrically somewhat complicated but it approximates the electrical condition shown in Fig. 2. As is well known, the surface of the insulator as it ages becomes slightly conductive even in dry weather conditions. When a mild rain occurs the outer surface $a-b$ becomes wet, and hence, more highly conductive, but the inner surface $b-c$ remains dry. This latter condition is represented in Fig. 2 by the dotted line between b and c which may be taken to indicate that the inner surface of the skirt is substantially an open circuit or an infinite resistance. Between a and b , however, a surface resistance is indicated in Fig. 2, and between this surface and the surface of the pin P a distributed capacity exists which is represented by the small condensers in Fig. 2. With this circuit any current that leaks from the line wire L to the pin P must pass through the elements of the surface resistance indicated between a and b and thence through the various capacities extending to the surface of the pin P. This results in an actual loss of energy due to the flow of the current in the surface resistance.

Obviously, if the surface resistance between L and b can be made either infinite or zero, there will be no actual loss of energy, for in the former case no energy can possibly be transmitted and in the latter case the transfer of energy is merely a wattless transfer through the distributed capacity illustrated in Fig. 2 by the several condensers. The former condition cannot be realized but the latter condition can be approximated by coating the outer surface of the insulator (from a to b) by some metallic conducting substance so that the surface resistance of the insulator is in effect short-circuited. While this will increase the capacity between the outer surface of the insulator and the surface of the pin P, since the transfer of energy will be wattless, the increased capacity is only of importance in so far as it introduces a phase change. Under mild weather changes this coating of the insulator gives very good results because the inner surface of the insulator from b to c will still be practically an open circuit.

If severe weather changes occur, however, the condition is different. A heavy rain may splash up and wet the entire inner surface of the skirt between b and c so that this surface now becomes in effect a fairly high resistance as indicated between b and c in Fig. 3. The same condition will occur in the case of a heavy snow, for the snow becomes packed up under the inner surface of the skirt. If, now, the outer surface of the insulator is coated, as is indicated at L' in Fig. 3 by the zero resistance conductor between a and b , we have a condition in which there is a large distributed capacity between the conductor L' and the wet inner surface, as indicated by the large condensers in Fig. 3. There will also be some distributed capacity between the pin and the relatively high resistance of the inner surface of the skirt, indicated between b and c in Fig. 3. This latter distributed capacity is represented by the small condensers in Fig. 3. Under certain weather conditions, the conductivity of the surface between b and c will be such that some alternating current energy will flow from the conductor L' through the resistance of the inner surface between b and c and thence through the

distributed capacity between said surface and the pin P, thus producing an actual loss in energy. This loss in energy may under severe weather conditions be greater at high frequencies than would be the case if the outer surface of the insulator were not coated. It will also be apparent that when the condition exists which is represented in Fig. 3, there will be an increase in the direct current leakage over the surface L' and thence over the inner surface of the skirt.

In accordance with the present invention it is proposed to overcome the difficulties above discussed by reversing the arrangement of the skirt so that the metallic conductor L' of the skirt will be embedded in dielectric instead of having a skirt of dielectric material coated by an external conductor. The reversed condition is indicated in Fig. 4. Here the conductor L' of the skirt is directly connected to the line wire L and is surrounded by a dielectric having surfaces represented at $a-b$ and $b-c$. Under mild wet weather conditions the outer surface $a-b$ will be partially conductive, but the inner surface is dry as represented by the dotted lines between b and c , and hence no substantial current, either direct or alternating, will flow from L to P along the surface of the insulator. So far as the transmission of alternating current is concerned, the metallic conductor L' effectively short-circuits the surface of the insulator and the transfer of alternating energy is a wattless transfer through the distributed capacity between the conductor L' and the surface of the pin P.

The arrangement indicated diagrammatically in Fig. 4 while entirely satisfactory under moderate weather conditions, would not function so effectively under extremely wet weather conditions, as the inner surface of the skirt might then become wet so that a condition somewhat analogous to that shown in Fig. 3 would result. In order to obviate this difficulty the electrical condition indicated in Fig. 5 would be desirable. Here we have in effect a skirt and a petticoat, both metallic and both embedded in dielectric material. The outer skirt L' will be conductively connected to the line conductor L and the metallic element of the petticoat P' will be in electrical contact with the surface of the pin P. In extremely severe weather conditions we would now have a partially conductive surface $a-b-c-d-e$. This surface would be protected against direct rain from b to c , c to d , and d to e . Consequently, under the most severe weather conditions there would be a relatively small direct current loss along the surfaces of the skirt and the petticoat. With regard to the transfer of alternating current energy, since the conductor L' is at all points at the potential of the line wire L and the conductor P' is at all points at the potential of the surface of the pin P, the only path for the transfer of alternating current energy is through the distributed capacity between the two conductive elements L' and P'. From an alternating current standpoint the surfaces $a-b-c$ and $c-d-e$ are each completely short-circuited and the transfer of energy from the line wire L to the surface of the pin P would be a substantially wattless transfer through the capacity between conductors L' and P'. In other words the alternating surface losses have been practically eliminated on these surfaces. Only in the immediate vicinity of c can such losses take place. As this surface is relatively only a small portion of the total insulator surface, and fur-

thermore as it is well protected from direct rain, the losses it contributes are relatively small.

An insulator embodying the principles of Fig. 5 is illustrated in Fig. 6. Here the insulator is made of two parts. An outer metallic element L' is spun to form a groove for the line wire L and a spreading skirt is represented between a and b. The entire inner surface of this metallic element is coated with enamel or other suitable coating material and the enamel coating is extended over the outer surface from b to a. The line wire is directly in contact with the exposed part of the metallic conductor L' which is above the lower flange of the line wire groove. The second element of the insulator comprises a metallic or conducting element P' spun to form a threaded portion above the point E, adapted to be threaded upon the metallic pin indicated in dotted lines at P, with a petticoat portion extending between e and d, this petticoat portion being of larger diameter than the pin P but smaller in diameter than the skirt portion of the conductor L'. The entire outer surface of the conducting element P' is coated with enamel or other insulating material and the insulating coating extends over the inner surface from d to e. The outer member L' is mounted upon the inner member as shown, and if desired a certain amount of dielectric cement may be interposed between the two parts to hold them rigidly together although, if desired, a certain amount of air space may be interposed between the two elements in the region of the screw-threaded part of the pin.

With this arrangement it is evident that an insulating surface extends from the line wire over both the inner and outer surface of the outer metallic skirt and thence over the outer and inner surface of the inner metallic petticoat and up to a point practically adjacent with the pin. The pin P, however, is in direct metallic contact with the upper part of the inner conductor P' and the line wire L is in direct metallic contact with the upper part of the outer metallic element L'. Consequently, all the points of the outer metallic member are at the potential of the line wire and all points of the inner conductor P' are at the potential of the pin. The surface of the insulating material is therefore completely short-circuited from an alternating current standpoint and the only possible transfer of alternating current energy must take place through the capacity between the two metallic conductors without being subjected to any resistance loss. Consequently the transfer of energy is purely wattless.

A modified arrangement is shown in Fig. 7. Here the outer metallic element or shell L' with its enamel coating D is similar to that of Fig. 6. But instead of mounting it on an inner enameled sheet surrounding the pin as in Fig. 6, the pin P is made of metal and its outer surface is covered with enamel D', the outer shell being then mounted in the pin and secured if desired by a layer of dielectric cement as shown. The analogy between this construction and that of Fig. 6 is obvious.

It will be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated, without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. An insulator structure including a line wire, an insulator and a conductive supporting pin, said

insulator having a skirt including a conducting element in metallic contact with the line wire and extending downwardly and so closely surrounding the supporting pin as to substantially prevent splashing its inner surface, said element being embedded in solid dielectric.

2. An insulator structure including a line wire, an insulator and a conductive supporting pin, said insulator having a skirt including a conducting element in metallic contact with the line wire and extending downwardly and so closely surrounding the supporting pin as to substantially prevent splashing its inner surface, said element having both its inner and outer surfaces coated with dielectric material.

3. An insulator structure including a line wire, an insulator and a conductive supporting pin, said insulator having a skirt including a conducting element in metallic contact with the line wire and extending downwardly and so closely surrounding the supporting pin as to substantially prevent splashing its inner surface, said element having both its inner and outer surfaces coated with dielectric material from a point adjacent the line wire to a point adjacent the pin.

4. An insulator structure including a line wire, an insulator and a conductive supporting pin, said insulator having a skirt including a conducting element in metallic contact with the line wire, said element being embedded in solid dielectric, and a petticoat comprising a conducting element in electric contact with the pin and embedded in solid dielectric.

5. An insulator structure including a line wire, an insulator and a conductive supporting pin, said insulator having a skirt including a conducting element in metallic contact with the line wire, said element having both its inner and outer surfaces coated with dielectric material, said insulator having a petticoat including a conducting element in electric contact with the pin and having both its inner and outer surfaces coated with dielectric material.

6. An insulator structure including a line wire, an insulator and supporting pin, said insulator including an element of conducting material formed to provide a groove for the line wire and in electric contact therewith, and a skirt surrounding the pin, said skirt being embedded in dielectric material.

7. An insulator structure including a line wire, an insulator and supporting pin, said insulator including an element of conducting material formed to provide a groove for the line wire and in electric contact therewith, and a skirt surrounding the pin, said skirt having both its inner and outer surfaces coated with dielectric material.

8. An insulator structure including a line wire, an insulator and supporting pin, said insulator including an element of conducting material formed to provide a groove for the line wire and in electric contact therewith, and a skirt surrounding the pin, said skirt having both its inner and outer surfaces coated with dielectric material from a point adjacent the line wire to a point adjacent the pin.

9. An insulator structure including a line wire, an insulator and supporting pin, said insulator including an element of conducting material formed to provide a groove for the line wire and in electric contact therewith, and a skirt surrounding the pin, said skirt being embedded in solid dielectric material, a second element of conducting material forming a petticoat surrounding the pin within said skirt and being in contact with

said pin, said second element being embedded in solid dielectric material.

10. An insulator structure including a line wire, an insulator and supporting pin, said insulator including an element of conducting material formed to provide a groove for the line wire and in electric contact therewith, and a skirt surrounding the pin, said skirt having both its inner and outer surfaces coated with dielectric material, a second element of conducting material forming a petticoat surrounding the pin within said skirt and being in contact with said pin, said second element having both its inner and outer surfaces coated with dielectric material.

11. An insulator structure including a line wire, an insulator and supporting pin, said insulator including an element of conducting material spun to form a screw-threaded portion to receive the pin and a petticoat to surround the pin, said petticoat being embedded in solid dielectric material, a second element of conducting material spun to form a grooved head surrounding said threaded portion and a skirt to surround said

petticoat, said skirt being embedded in solid dielectric and said grooved head being in electric contact with the line wire, and insulating material between said elements.

12. An insulator structure including a line wire, an insulator and supporting pin, said insulator including an element of conducting material spun to form a screw-threaded portion to receive the pin and a petticoat to surround the pin, said element having its entire outer surface coated with dielectric material and the inner surface of its petticoat coated with dielectric material from the bottom to a point adjacent said screw-threaded portion, and a second element of conducting material spun to form a grooved head surrounding said threaded portion and a skirt to surround said petticoat, said grooved head being adapted to receive the line wire and said second element having its entire inner surface coated with dielectric material and the outer surface of its skirt coated with dielectric material from the bottom to a point adjacent the line wire.

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